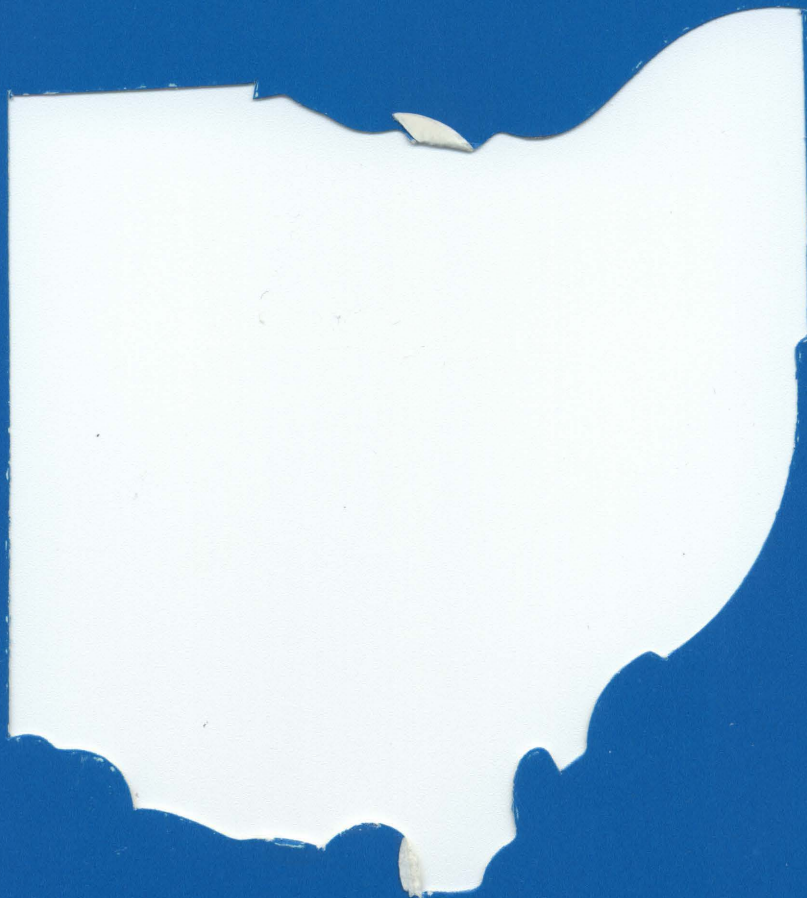


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Structural Transformation of the
U.S. Potato Industry

by

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Introduction

Structural changes have completely transformed the U.S. potato industry. This transformation, during the past three decades, has resulted from factors both external and internal to the potato industry. External changes of great significance include (a) an increasing demand for away-from-home food consumption, (b) a rapidly expanding fast food sector, (c) a changing labor force composition, (d) a rising per capital income, and (e) a growth of population. Internal industry changes of major importance include (a) a falling demand for fresh potatoes, (b) a rising demand for processed potatoes, (c) a declining number of raw potato producers, (d) a declining number of potato processors, and (e) a spatial redistribution of production, both raw and processed forms.

These changes, while recognized by many researchers, have not been analyzed within a systematic framework to examine their interactions and effects on other facets of the industry. To this end, a simultaneous equation model consisting of sixteen equations was developed and estimated (Jones, 1984). This model, estimated with 1960-81 data, encompassed all raw potatoes and all processed potato forms. Processed forms were grouped together for estimation purposes. For example, no attempt was made to estimate the demand for chips separate from that for frozen potatoes. Descriptive characteristics of various product forms, however, are given. Aggregation of data was used for ease of estimation and clarity of interpretation. Significant findings of this study are discussed after a brief industry overview.

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Overview of Potato Industry

Potatoes are a commodity with an extremely high economic value. Since 1950, potatoes have consistently accounted for over 45 percent of the total value of major vegetables. At the farm level, potatoes had an economic value in 1950 of \$482.1 million (1967 dollars) and accounted for 47 percent of the value for major vegetables. By 1981, this value had increased to \$674.5 million and the proportion to 54 percent. In current dollars, potatoes have exceeded \$1 billion since 1973.

Farms producing potatoes totaled 1.6 million in 1950 with an average size of .9 acre. Production amounted to 259.1 million hundredweights (cwts), with 167.4 million cwts or 64 percent going for fresh consumption. In per capita terms, fresh consumption amounted to 100 pounds and processed consumption to 6.3 pounds. By 1981, processed consumption had climbed to 65.4 pounds while fresh consumption had fallen to 48.2 pounds (Figure 1). Despite these dramatic changes in the composition of consumption, total consumption during this period increased, reaching a high of 120.5 pounds in 1975.

Before the tremendous shift to processed potato products, production of raw potatoes was heavily concentrated in the Northeastern states. In 1950, for example, the New England states together with Pennsylvania and New York accounted for 17 percent. By 1981, the Pacific Northwest had increased its share of production from 17 to 47 percent. Production in the Northeast had fallen from 29 to 13 percent. These production shifts resulted in increased production just as the consumption shift resulted in increased consumption. Production increased during the 1950-81 period from 259.1 billion cwts to 338.6 billion cwts, an increase of 30 percent. This increase occurred despite a 98 percent decline in farms producing potatoes, a decline from 1.6 million in 1950 to 27 thousand in 1982. As this process evolved, farms remaining in production

PER CAPITA CONSUMPTION OF POTATOES

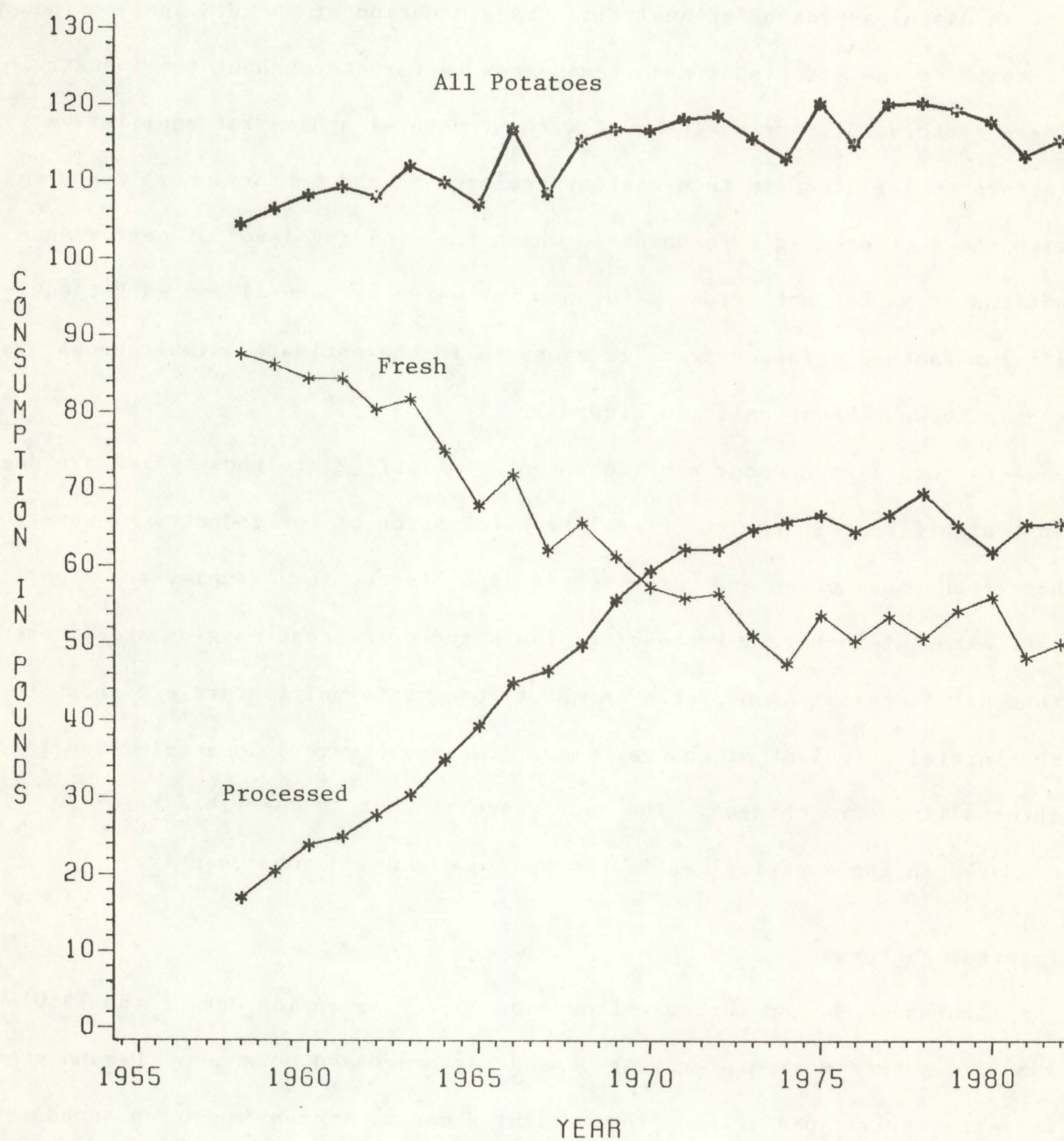


Figure 1 -- Per Capita Consumption of Fresh and Processed Potatoes, 1958-82.

increased in size and raised their productivity to expand both total acreage and production.

Industry Changes: Causes and Consequences

A useful approach for analyzing transformation of the U.S. potato industry is to trace the effects of major exogenous factors throughout the industry. These factors, of course, interact with structural and market equilibrium factors to influence in turn market participants and performance. Concurrent with these changes is a feedback in which the evolving level of performance and actions of market participants further influence structural and market equilibrium factors. This process is captured in the estimated simultaneous system and is shown schematically in Figure 2.

Factors listed under each component of Figure 2 are those which are deemed most significant in the structural transformation of the industry. Away-from-home food consumption and women in the labor force, for example, are significant external factors. Processing plants and price cost margins are important internal factors. As depicted in the figure, external factors are shown to be the initial stimulant of change. This process, however, is accelerated through internal industry changes. The confluence of what is described here is captured in the empirical estimates and is discussed subsequently.

External Factors

Increased demand for away-from-home food consumption during the 1950's and 1960's set into motion a growing demand for processed potatoes. Demand growth was especially rapid at fast food establishments, increasing at an annual rate of 37 percent between 1958 and 1972. Growth at non fast food establishments, by comparison, was 2 percent per year (Figure 3). Fast food growth was especially pronounced in accelerating away-from-home consumption of frozen

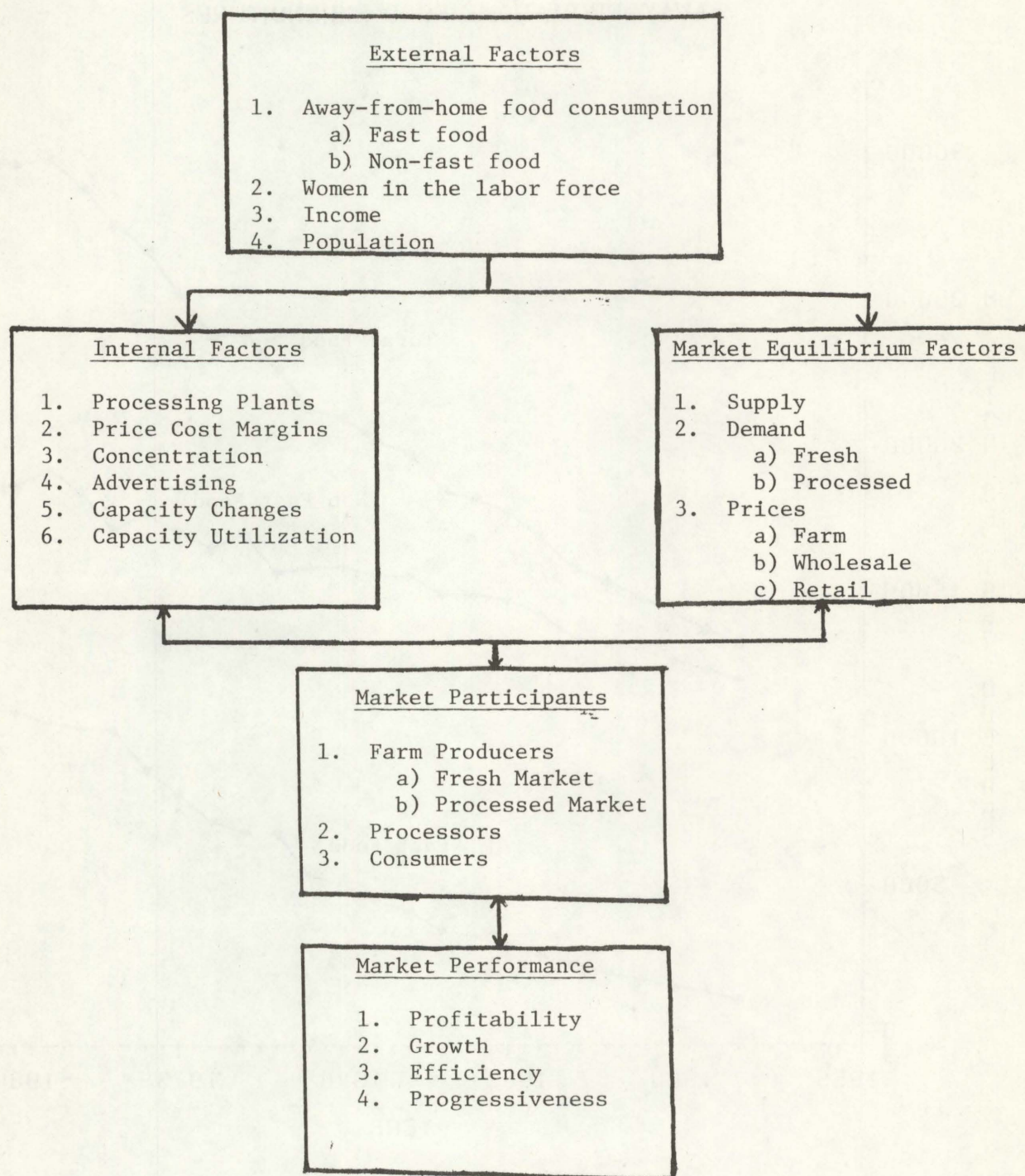


Figure 2 -- Schematic diagram of Structural Change in the U.S. Potato Industry.

AWAY-FROM-HOME FOOD EXPENDITURES

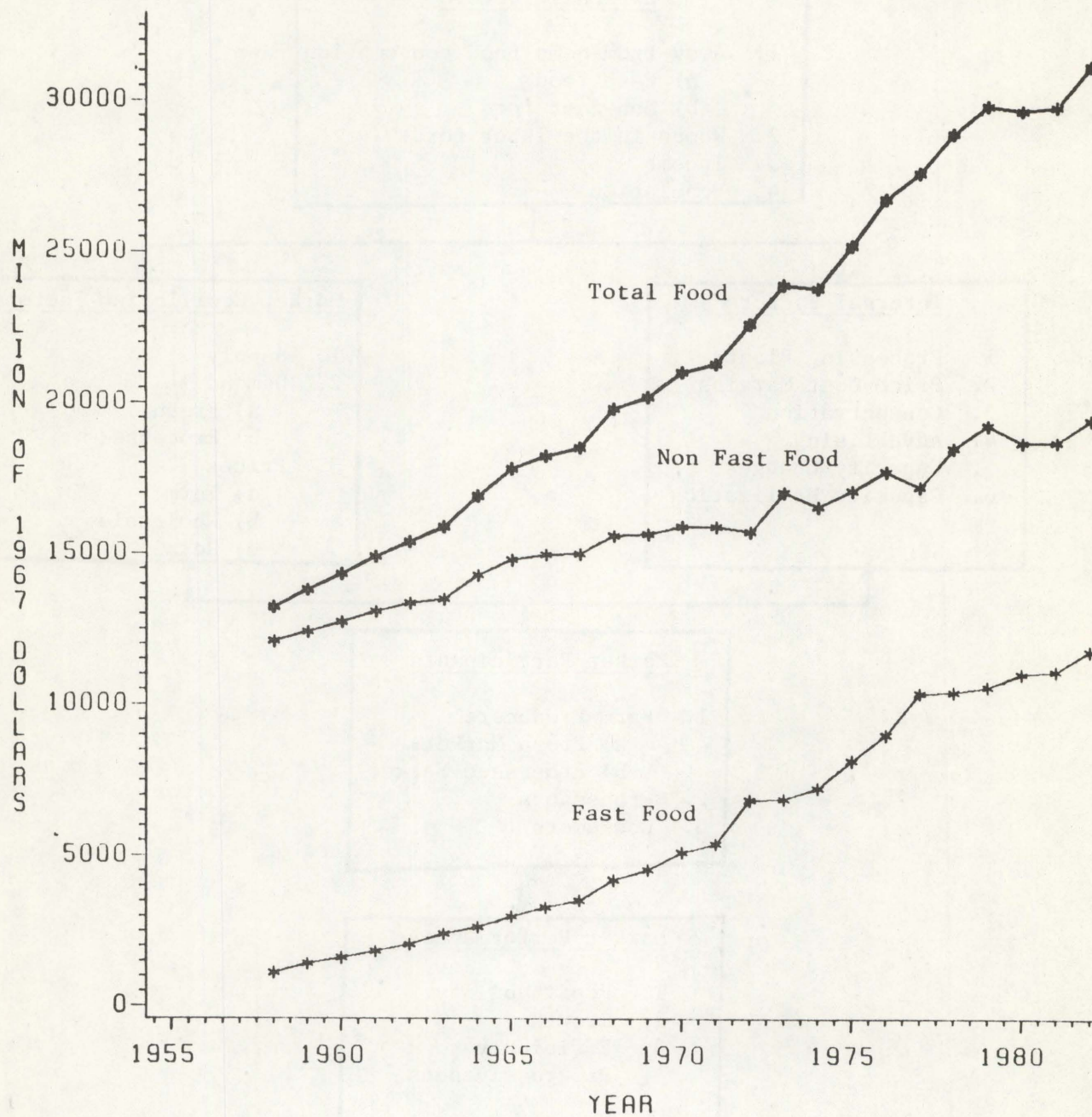


Figure 3 -- Away-From-Home Food Consumption Expenditures, 1958-82.

potatoes. This relationship evolved from the prevalence of frozen french fries at fast food establishments. Seven of every ten non breakfast patrons of these establishments order french fries as part of their entree (Cox, 1982).

The empirical results show a .06 percent increase in demand for processed potatoes for each 1 percent increase of fast food expenditures. A 1 percent increase in total away-from-home expenditures, by comparison, increases processed demand by .07 percent, a difference of .01 percent. These elasticities clearly indicate a stronger demand for processed potatoes at fast food establishments than at non fast food ones.

Concomitant with the growth of away-from-home food consumption are significant changes in U.S. labor force composition (Figure 4). Women entered the labor force at the start of the 1960's in unprecedented numbers. This entry not only reinforced a growing demand for away-from-home food consumption, but enhanced in-home consumption of processed potatoes. This latter effect stems from a direct relationship between growth of women in the labor force and growth in demand for convenience foods (Jones and Zepp, 1983).

Growth of women in the labor force serves not only to enhance greatly the demand for processed potatoes, but to diminish severely the demand for fresh potatoes. A 1 percent increase of women in the labor force generates a .17 percent increase in demand for processed potatoes but a .24 percent decline in demand for fresh potatoes. This differential together with those found for other exogenous factors suggests that increases in total potato consumption have resulted from more than just exogenous factors. These additional factors are discussed subsequently.

Income and population growth are exogenous factors which serve to enhance demand for processed potatoes. Fresh demand is retarded by growth of these factors. Demand for some processed potatoes is enhanced by income growth as well as income stagnation or decline. This apparent paradox evolves from the

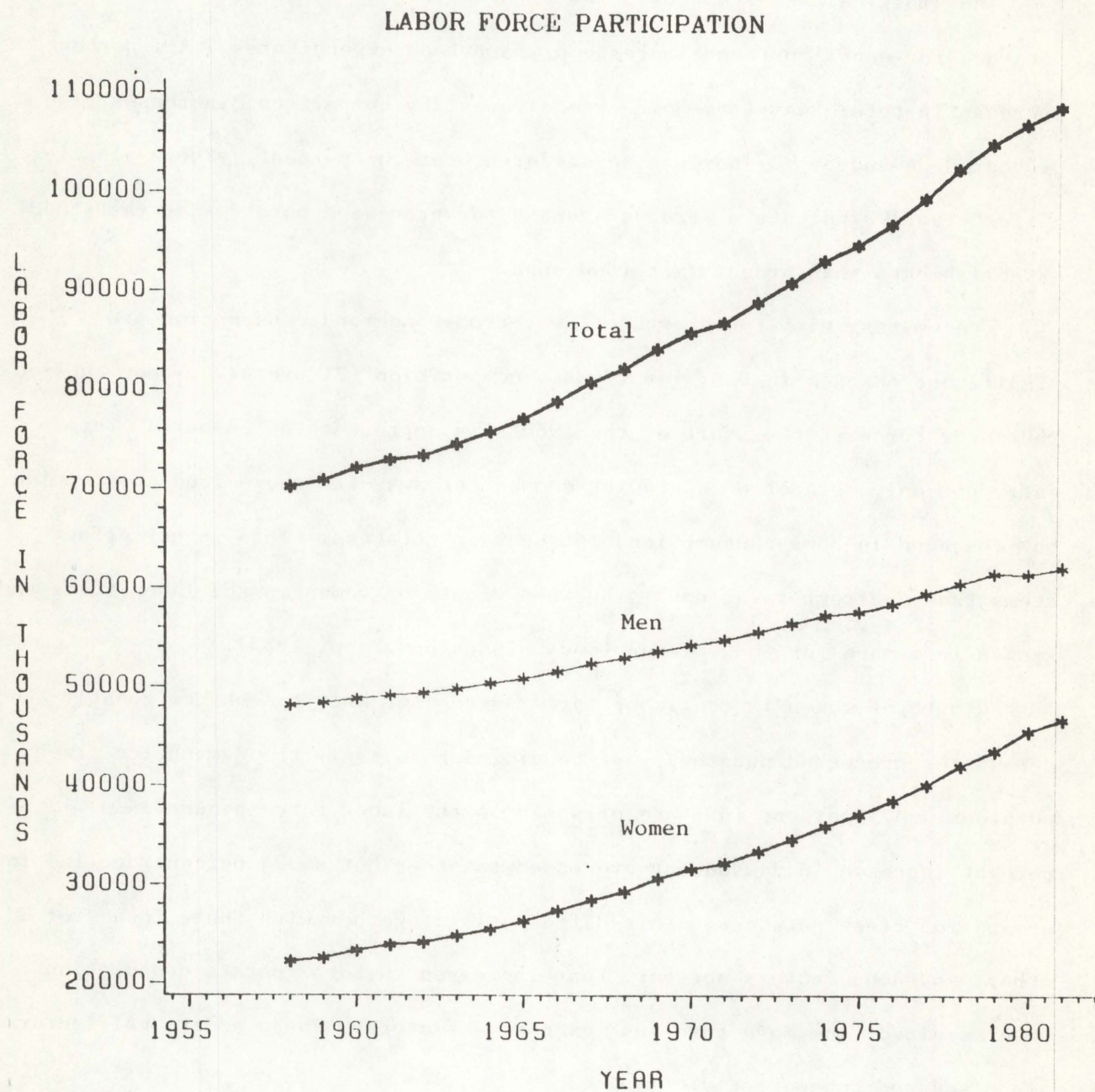


Figure 4 -- U.S. Labor Force Composition, 1957-81.

fact that many diners of upscale restaurants "trade down" to fast food establishments during less favorable economic times when income may be constant or falling. With 70 percent of all frozen potatoes being sold at institutional establishments, plausibility is given to this ostensible paradox.

Results of the estimated model show that a 1 percent increase in income generates a .27 percent increase in processed demand and a .24 percent reduction in fresh demand. An increase in population of 1 percent, by comparison, increases processed demand .32 percent and decreases fresh demand .36 percent. These income elasticities indicate that consumers readily switch from fresh to processed potatoes as their income rises. Population elasticities suggest that growth in consumption of processed potatoes could occur even with constant per capita consumption.

Internal Factors

Concurrent with the aforementioned external changes in the U.S. economy were significant internal structural changes. Technological advances in potato processing led to significant increases in the size of potato processing plants, but major reductions in the number of processing plants. Plants declined from 446 in 1959 to a 1981 level of 221. During this same period, the average size of a plant processing frozen potatoes increased from an average capacity of 5,000 pounds to 45,000 pounds per hour (processed weight). Similar size increases occurred in plants processing dehydrated potatoes and potato chips. As larger firms adopted these scale technologies with their inherent greater efficiency, smaller firms were placed at a competitive disadvantage. This disadvantage was further aggravated by market share gains and increased advertising of larger processors.

As shown in Figure 5, advertising expenditures have been disproportionately concentrated on potato chips. Dehydrated potato products were heavily advertised during the early 1960's but expenditures have since fallen dramatically. Frozen potatoes have received sizeable advertising increases since the early 1970's. Large differentials in advertising expenditures for chips and frozen potatoes are due primarily to differences in marketing channels. Chips are marketed largely through retail establishments, roughly 72 percent in 1981. Frozen potatoes, by comparison, are marketed predominantly through institutional establishments, approximately 76 percent in 1981. Institutional establishments (hotels, cafeterias, restaurants, etc.) are less susceptible to product differentiation which is often achieved with advertising. Consumers, however, are quite susceptible to advertising messages and are therefore inundated with them on products like chips which are purchased through retail establishments.

Advertising expenditures on potato chips coupled with other factors were especially effective in differentiating the product, enhancing market shares, and driving smaller chipping firms from the industry. The top four chip processors, for example, increased their market share from 36 percent in 1959 to a 1982 level of 60 percent. Plants processing chips declined during this period from 413 to 169. These abandoned plants were most frequently owned by smaller firms. Indeed the empirical results show a .7 percent market share gain for the top four processors (all products) for each loss of 100 plants. A 1 percent increase in advertising expenditures would amount to \$31.7 million.

Empirical estimates further show that market share gains for the larger processors are enhanced by increased capital and transportation cost. Increased capital cost disproportionately impact smaller processors because unavailable internal capital force them, unlike larger processors, into capital markets. Increased transportation cost has a more pronounced effect on smaller

ADVERTISING EXPENDITURES FOR PROCESSED POTATOES
 ---CHIPS (*), FROZEN (F), DEHYDRATED (D), TOTAL (+)---

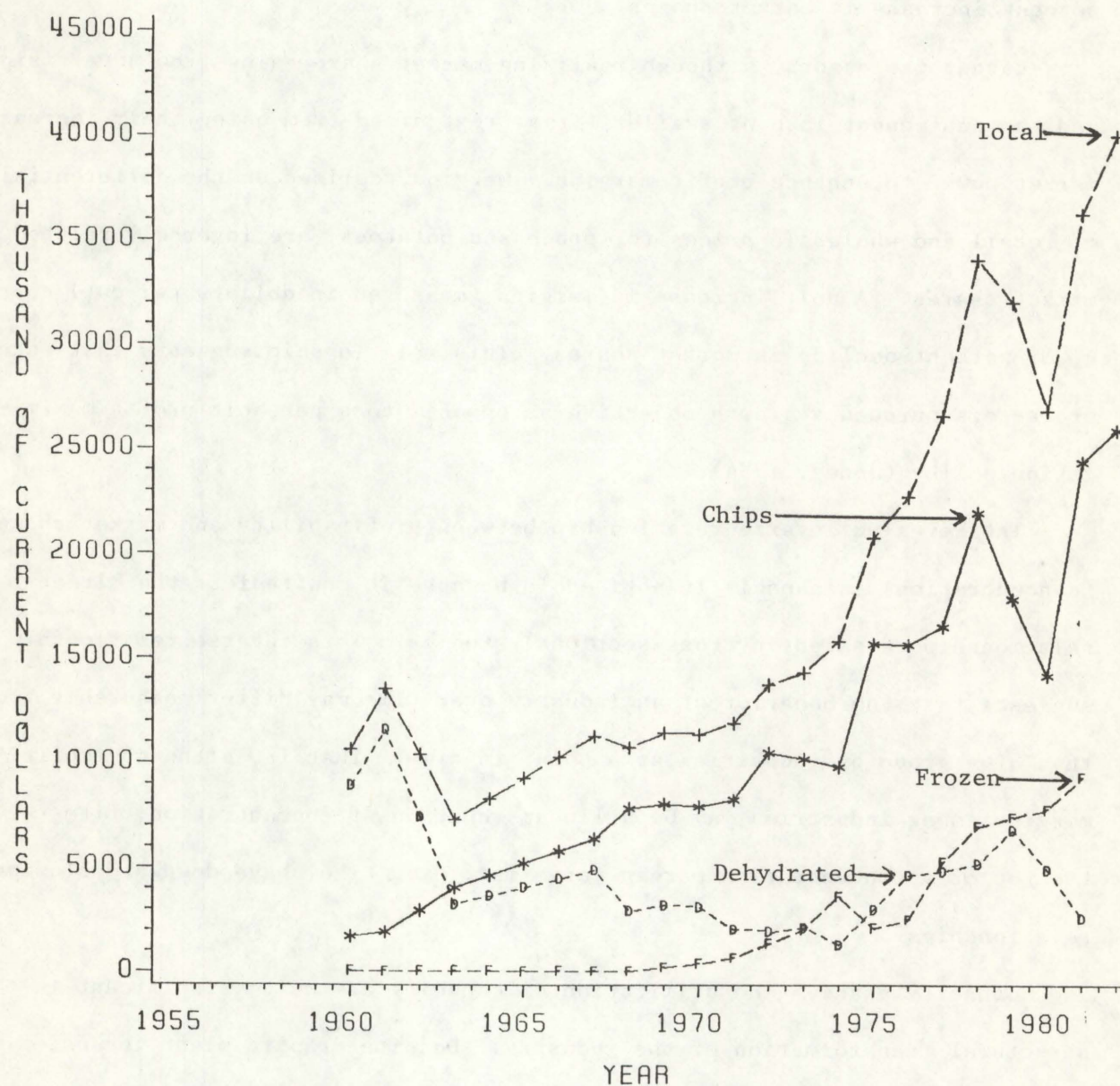


Figure 5 -- Advertising Expenditures for Processed Potatoes, 1960-81.

processors because these costs are spread over fewer units. Estimated results show a .07 percent increase in market shares for the top four potato processors for each unit increase of transportation cost (dollars per gallon of diesel fuel). An increase in capital cost (interest rate) of one unit generates a .15 percent increase in market shares.

Larger processors, although realizing market share gains from advertising and the subsequent loss of smaller firms, restrained from using their increased market power to enhance profit margins. Margins, defined as the differential of retail and wholesale prices for processed potatoes, are inversely related to market shares. A unit increase in margins (measured in dollars per cwt) causes a .39 percent decline in market shares. This relationship suggests that potato processors pursued a growth objective as opposed to a per unit profit maximization policy (Jones, 1984).

The revealed inverse relationship between profitability and market shares (concentration) is especially noticeable because it contradicts the direct relationship revealed in cross-sectional studies. This inverse relationship suggests that the behavior of an industry over time may differ measurably from that of a group of industries at a point in time. That is, although profit margins among industries may be a linear function of concentration, firms at the top of a concentration-margin curve may, over time, have downward sloping relationships.

Capacity changes and utilization of capacity are quite significant in the structural transformation of the industry. Despite drastic plant losses, potato processing capacity is greatly expanded through increased plant size. Processing capacity for frozen potato products, for example, increased from 1.1 billion pounds in 1960 to a 1982 level of 6.1 billion pounds. Much of this growth occurred during the 1960's as the sector tripled its capacity. Rapid growth during the 1960's resulted in relatively low utilization rates,

averaging 54 percent for the decade. This rate increased to 65 percent during the next decade.

Capacity utilization is, as hypothesized, positively related to demand for processed potatoes. Empirically, a 10 pound increase in per capita demand for processed potatoes generates a .007 percent increase in capacity utilization. A 1 percent increase in total capacity generates a .008 percent decline in capacity utilization. This inverse relationship suggests that potato processors expand capacity to accommodate not only existing demand but also anticipated demand growth. As anticipated demand growth materializes, capacity utilization is enhanced.

Empirical results show an inverse relationship between capacity utilization and price cost margins. Increased capacity utilization has been generally associated with growing demand and therefore a favorable environment for enhancing per unit profit rates (Sawhney and Sawhney, 1973). As explained earlier, since potato processors are inclined to reduce profit margins in favor of growth and expansion, this revealed inverse relationship between capacity utilization and margins is consistent with a growth objective. Empirical results further show that increases in total capacity tend to diminish capacity utilization. Both total capacity and capacity utilization are, however, enhanced by higher margins. Growth of total capacity is hampered by increased capital cost. Slower capacity expansion coupled with increased demand pushed the frozen potato sector to a 1981 capacity utilization rate of 70.5 percent.

Market Equilibrium and Participants

Market equilibrium characteristics, price-demand-supply, of the U.S. potato industry have undergone a complete transformation. Inextricably linked to this transformation have been the participants in the formation of supply,

demand and price. Potato production has been radically transformed in terms of farm size, number and location. Fundamental changes also have occurred in the risk and uncertainty which influence production. An all encompassing change, however, has been the demand shift from fresh to processed potatoes. This shift has impacted not only potato prices at the farm, wholesale and retail level but also marketing institutions at each level.

Although potato production has trended upward during the past three decades, its path has been quite erratic. Large fluctuations in production have occurred because of uncontrollable factors such as weather and pests. Fluctuations resulting from undercapitalization of producers have diminished as large potato processors have advanced preseason contracts to producers. Recipients of these contracts have been large and specialized producers for the processed market. Producers on small farms with little or no specialization have received fewer contracts because their limited production is considered insufficient to justify the production services which accompanied contracts. That is, to obtain potatoes with desirable processing characteristics, potato processors provide technical assistance, time and knowledge of technicians, to assist producers. This discriminate use of preseason contracts place small and/or fresh producers at a competitive disadvantage to large and/or processed producers.

Failure to secure preseason contracts together with diminished terminal markets for potatoes lead ultimately to the demise of many small producers. To prolong their existence and raise farm-level potato prices, many potato producers resort to the formation of bargaining associations to negotiate preseason contracts with processors. This process also is intended to provide some equality of contract prices among producers in a given area or

region. The effects of preseason contracts on potato prices are indeterminate because of insufficient information on contract prices. It is known, however, that contracts diminish the role of supply and demand in price determination.

Production of potatoes during the past three decades has been influenced mainly by prior potato prices. A \$1 per cwt increase in the farm price of potatoes during the previous year generates a per capita production increase the following year of 21 pounds. This translates into a price elasticity of supply of .31. That is, a 1 percent increase in price causes a .3 percent increase in supply. The price of sugar beets is used in the model to capture substitutability between potatoes and sugar beets. The empirical results show sugar beets to be at best an imperfect crop substitute. Production of potatoes falls by .1 percent for each 1 percent increase in the price of sugar beets.

Consumption of potatoes shifts toward processed products as the external or exogenous factors listed in Figure 2 change. These same factors, as noted, serve to diminish consumption of fresh potatoes. In addition to these factors, the empirical estimates reveal that the price of fresh potatoes is an insignificant determinant of fresh consumption. That is, fresh potatoes appear to be such a small proportion of consumers' food budget that a constant amount is purchased irrespective of price changes. Processed potatoes, on the other hand, are shown to be quite responsive to price changes. Consumption declines by .43 percent for each 1 percent increase in processed prices. Consumption of fresh potatoes, by comparison, increases by .34 percent for each 1 percent increase of processed prices. These elasticities reveal that consumers have a strong preference for processed potatoes over fresh ones, but do switch to fresh potatoes as significant increases are realized in processed prices.

Continual decline in consumption of fresh potatoes has prompted the potato industry to institute a revenue-earning tax to promote increased potato consumption. The industry established the Research and Promotion Act of 1971

which stipulated a mandatory withholding of one cent per cwt on all potatoes. The empirical results show that these promotional efforts are either too little or too recent to have measurable impacts on fresh consumption. Consumption of processed products, as explained earlier, are greatly influenced by advertising. This differential impact of advertising expenditures on fresh and processed potatoes may indeed be a function of the imbalance in advertising expenditures on the respective products. That is, advertising of fresh potatoes may not have reached a threshold level.

Prices of raw potatoes at the farm and retail levels have shown tremendous fluctuation during the past three decades. Much of this fluctuation is probably attributable to transformations within the industry. For example, the shift to processed products generates a demand for potatoes with specific processing characteristics. Potatoes meeting these characteristics are sold at a premium price while others are sold for a lower price. Analyses of the farm and retail prices of raw potatoes show that fluctuations in the former are inversely and clearly linked to production while fluctuations in the latter show no identifiable pattern with production. This suggests that price changes at the wholesale level are transmitted through at the retail level on a delayed or partial basis.

Processed potato prices have fluctuated moderately at the wholesale and retail levels, unlike the tremendous period-to-period fluctuation shown in fresh prices. A one unit change in the wholesale price results in a 1.7 unit change in the retail price. This suggests that all price changes at the wholesale level, plus an element of profit, are passed on to consumers at the retail level. The empirical results further reveal a widening over time of the differential between the wholesale and retail price.

Significant changes which are not captured in the estimated model involve the institutions handling potatoes. At the farm level, producers have greatly reduced their sorting, packing and storage of potatoes. These services have diminished in importance because large processors and grocery chains have developed the diversification to perform them. Similarly, procurement of potatoes through contracts by these potato buyers has led to a significant reduction in the number of shippers and brokers handling potatoes at the wholesale level. Reduced demand for shippers and brokers has carried over to the retail level as many processors have initiated a plant-to-customer distribution network.

Market Performance

Market performance for the U.S. potato industry, as used here, is evaluated in the context of consumer satisfaction at the retail level. As demand shifted from fresh to processed potatoes, the industry adapted to this shift and readily made processed products available. In fact, through advertising and other promotional efforts, the industry attempted to influence and accelerate the demand for processed potatoes. Accelerated demand growth, however, was not at the expense of product quality. Resources were allocated to improve the taste and nutrition of processed potatoes. As a result of these efforts, innovative steam peeling methods were developed and adopted which greatly diminished the loss of nutrients. Consumer surveys also suggest that significant improvements were made in the taste of processed products. Fresh potatoes were also improved in quality as processors sorted "top grade" potatoes for the fresh market.

Adjustments in the industry to accommodate shifting demands did not result in increased profit margins. As the empirical results show, the industry undoubtedly followed a growth policy rather than a per unit profit maximization

policy. Reduced profit margins, however, led to the demise of many processors, especially smaller ones. Economic theory would suggest that these departing firms were less efficient than those remaining. Through reduced production cost and improved resource allocation, this process should have enhanced market performance.

Lower per unit margins did not erode total profitability of the industry. This is evident from the fact that resources were continually allocated to the development of new products and technology. Adoption of new and improved technology was indeed a significant factor in the development and growth of processed potatoes. In summary, technological efficiency and product improvements were major factors which accelerated growth of the processed potato sector.

A negative factor associated with the growth of the processed sector is a decline of the fresh potato sector. This, however, does not suggest poor industry performance. Indeed poor performance would have resulted if the industry had continually supplied fresh potatoes when consumers demanded processed ones. Since the decline of the fresh sector appears totally related to consumer demands, this decline cannot be a negative factor in evaluating industry performance. Likewise, the decline of fresh market participants--producers, brokers, shippers, etc.--also must be considered a change associated with a more efficient allocation of resources. In short, the industry reallocated resources to accommodate adjustments in consumer demands.

Summary and Conclusion

The growth of fast food expenditures and women in the labor force, shown in Figures 3 and 4, are significant factors in the transformation of the U.S. potato industry. Fast food expenditures are the dominant factor in the growth of the leading processed product, frozen french fries. Women in the labor

force not only accelerate the growth of fast food expenditures, but also increase in-home consumption of processed potatoes. Changes in these two external factors reverberate throughout the potato industry. Increased demand for processed potatoes lead to fewer but larger plants, accelerated adoption of improved technology, increased contract procurement of potatoes, increased advertising expenditures, and so forth.

Extrapolation of the empirical results beyond the data period to 1990 suggests that rapid change will continue throughout this period. Growth of fast food expenditures and women in the labor force are shown to provide much of the thrust for growth of processed products. A decline or stagnation in either of these factors would greatly reduce the external stimulant for growth. Internal industry changes, however, could compensate for a reduced external stimulant. Increased advertising and other promotional efforts, for example, could accelerate consumption of processed products. Increased fresh consumption, in the absence of a major advertising effort, seems dependent on market acceptance of fresh potatoes at institutional establishments. The growing consumption of baked potatoes at fast food establishments seems suggestive of an emerging, upward trend in fresh consumption.

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